BOTANICAL GAZETTE

JUNE, 1894.

Leaf movement in Cercis Canadensis.

S. G. WRIGHT.

WITH PLATES XIX AND XX.

Among the numerous observations which have been made concerning leaf movement the bulk of attention has probably been given to the investigation of the especially interesting phenomena connected with Mimosa pudica. The histological structure and development of the unusually sensitive pulvinus of this plant has been quite fully described. Numerous other members of the Leguminosæ have well marked pulvini and offer admirable opportunities for physiological and histological study. *Cercis Canadensis* L., while presenting less noticeable leaf movement than the sensitive plant, proves on closer examination to be a very interesting subject for investigation.

In external appearance the pulvini on a mature leaf of Cercis Canadensis consist of prominent enlargements at both the upper and lower end of the petiole. The enlargement at the junction of the petiole and leaf lamina is the principal one in producing the leaf movement, while the enlargement at the basal end of the petiole so far as movement is concerned seems to be almost functionless. In a series of observations made on a number of leaves (given in tabulated form later) no movement of any importance could be detected in the basal pulvinus. The upper or true pulvinus of one of the largest leaves found on a thriftily growing tree gave the following measurements.

Length on upper surface	5. mm
Length on lower surface	7.5 mm
Horizontal diameter, lower end	3. mm
Horizontal diameter, upper end	2.5 mm
Average horizontal diameter of petiole	2. mm
Average vertical diameter of petiole	1.8 mm

In the true or upper pulvinus, which shall receive the bulk of attention in this paper, the upper end may be said to form a portion of the upper surface of the lamina of the leaf, while the leaf veins, seven in number, of which the central one is probably twice the size of either of the others, are given off from its margin. An upper view of the mature pulvinus is given in plate XX, fig. 3. When a mature pulvinus presents a series of transverse markings or wrinkles it may be taken as an indication that the leaf is capable of very great movement. This is found to be quite true in the case of the plant under study. In a series of observations made on a number of leaves at different times during the day it was found that the angle between the petiole and the lamina varied nearly 100 degrees. With slight modifications due to variations in temperature and light the daily movement of the leaf may be said to be as follows: The rise, beginning approximately at 3 A. M. is continued quite rapidly until 9 A. M. A slight decline then occurs, the lamina again rising to near its forenoon position at about 2 P. M. After this time rapid falling takes place, the full sleep position being reached at about 10 P. M.

1. MOVEMENT OF UPPER PULVINUS. FIRST DAY.

TIME OF DAY.	ANGLE OF LEAF-BLADE WITH PETIOLE IN DEGREES.						TEMPERATURE. °F.	AVERAGE MOVEMENT IN DEGREES.
	LEAF 1.	LEAF 2.	LEAF 3	LEAF 4	LEAF 5.	LEAF 6.		
2:30 A.M.	41	41	21	30	32	18	80	
5	93	97	63	90	75	78	82	52.16
6	104	113	78	102	97	100	82	16.33
7	118	127	83	117	111	113	76	13.33
8	112	127	82	118	105	111	76	− 3.16
9	92	129	78	104	97	107	76	− 8.
10	91	125	79	90	96	104	85	− 3.66
11	85	118	67	75	72	91	87	−12.83
12 M.	83	112	56	60	67	77	88	− 8.83
1 P. M.	88	104	60	61	68	83	88	1.5
2	95	111	63	73	71	91	85	6.66
3	105	125	73	81	84	91	80	9.16
4	114	128	80	91	90	94	78	6.33
5	127	144	92	113	116	112	76	17.83
6	112	131	95	113	103	95	71	− 9.16
7	101	114	85	87	90	86	71	−14.33
8	84	91	74	70	71	72	67	−16.83
9	71	77	58	58	57	50	65	−15.16
10	60	61	43	60	46	36	66	−10.83

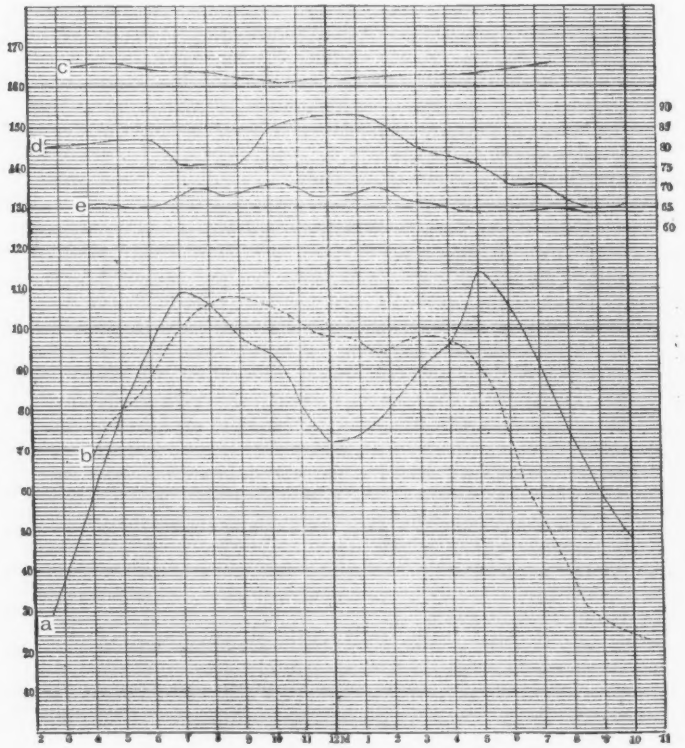
2. MOVEMENT OF UPPER PULVINUS. SECOND DAY.

TIME OF DAY.	ANGLE OF LEAF-BLADE WITH PETIOLE IN DEGREES.						TEMPERATURE. °F.	AVERAGE MOVEMENT IN DEGREES.
	LEAF 1.	LEAF 2.	LEAF 3.	LEAF 4.	LEAF 5	LEAF 6.		
4 A.M.	85	81	51	76	71	65	66	
4:30	91	91	59	81	81	76	66	8.33
5:30	97	101	68	85	82	89	65	7.16
6:30	105	114	80	100	94	101	65	12.
7:30	119	124	89	106	100	110	70	9.
8:30	121	131	90	115	104	113	68	4.33
9:30	127	131	90	113	101	106	70	— 1.
10:30	123	134	91	96	90	116	71	— 3.
11:30	115	125	90	93	87	111	68	— 4.83
12:30 P.M.	110	122	92	92	88	113	68	— .66
1:30	108	118	85	89	84	109	70	— 4.
2:30	110	123	90	90	84	114	67	3.
3:30	115	120	94	90	83	112	66	.5
4:30	116	120	94	83	75	110	64	— 2.66
5:30	109	109	95	69	59	97	64	—10.
6:30	85	80	71	51	40	65	64	—24.33
7:30	72	68	55	38	24	46	65	—14.83
8:30	56	51	37	24	19	29	64	—14.5
9:30	49	40	29	23	17	30	64	— 4.66
10:30	45	37	21	20	17	30	64	— 3.

3. MOVEMENT OF LOWER PULVINUS.

TIME OF DAY.	ANGLE OF PETIOLE WITH STEM IN DEGREES.												TEMPERATURE °F.	AVERAGE MOVEMENT IN DEGREES.
	LEAF 1.	LEAF 2.	LEAF 3.	LEAF 4.	LEAF 5.	LEAF 6.	LEAF 7.	LEAF 8.	LEAF 9	LEAF 10.	LEAF 11.	LEAF 12		
3:30 A.M	180	146	150	180	172	160	165	150	143			171	65	
4:30	180	143	152	180	174	162			143	171	175	171	66	.8
5.30	178	150	152	180	175	160	161	150	145	165	173	171	65	— .6
6:30	175	146	150	183	172	163	168	151	144	167	172	166	66	-1.25
7:30	177	146	152	177	172	163	171	150	144	163	172	163	70	.16
8:30	171	142	150	176	171	160	163	150	145	167	173	170	63	-1.08
9:30	170	143	151	174	170	160	165	149	143	163	163	170	70	-1.33
10:30	170	143	15	176	169	158	165	148	149	163	166	168	71	— .92
11:30	171	143	151	174	171	158	168	149	144	162	163	170	63	.66
12:30 P.M	172	142	150	173	169	161	166	149	142	164	164	163	63	— .33
3:30	170	140	152	176	169	164	168	153	142	163	163	170	65	1.41
4:30	172	141	151	173	165	162	166	154	144	167	169	167	64	— .33
5:30	171	143	152	177	168	162	169	150	142	167	168	168	64	.92
6:30	173	145	150	177	170	164	167	155	145	169	169	169	64	.83
7:30	178	147	154	175	171	162	167	153	145	170	170	169	65	.58

Above in tables 1, 2 and 3, are given the various observations as made on a number of leaves. Tables 1 and 2 show the observations made on the upper pulvinus during two consecutive days. Table 3 shows the observations made on the lower pulvinus during a single day. The time of day at which each observation was made is given in the left hand



LEAF MOVEMENT AND TEMPERATURE CURVES.

column. In the central part of the table are given the exact readings in degrees as made on the separate leaves. In the column at the extreme right is given the average movement in degrees for the entire number of leaves observed, during the time between observations. The downward movement

in each case is marked with a negative sign. The temperature at the time the observation was made is given in a column near the right.

These observations were made about the first of March on small plants grown in the green house that were brought from the forest in the previous autumn. The average movement given in the last column in each table together with the temperatures are shown above plotted in the form of curves. Curves *a*, *b*, and *c* correspond respectively with tables 1, 2, and 3. Curves *d* and *e* are temperature curves; *d* corresponding with table 1, and *e* with tables 2 and 3 (the observations in tables 2 and 3 being made at the same time). In plotting curves *a*, *b*, and *c* the average position of the leaves at 5 o'clock A. M. is taken as a starting point in each case, thereby admitting of the graphical representation of the actual position of the leaves at any given time as well as of their average movement. The degrees of the angles are represented on the ordinates, and the time in hours on the abscissæ. The noon point is marked 12 M. Fractions of a degree less than five-tenths are not taken into account, but when five-tenths and over they are counted as one. The degrees of temperature for curves *d* and *e* are indicated at the right near the top. In comparing curves *a* and *b* it will be seen that in *b* the forenoon maximum is reached much later, and that the fall of the leaf in the afternoon takes place much earlier than in *a*. This may be attributed to the fact that in *b* the temperature was much lower than in *a* (see temperature curves *e* and *d* respectively), and that the movements represented by curve *b* were on a cloudy as compared with a bright sunny day in the case of *a*. Curve *c* is to represent the results of the observations made on the basal pulvinus, as given in table 3. The curve seems to indicate a slight decline of the petiole during the middle of the day, but on account of the difficulty experienced in reading the leaf angles to fractions of a degree, I do not feel safe in giving this as a final conclusion. Fig. 1 and 2, plate XIX, are from photographs and show respectively the position of the leaves at night (three o'clock A. M.), as compared with their position in the daytime (eight o'clock A. M).

For the histological investigation of this subject a series of twelve collections were made, beginning with the first swelling of the leaf buds in spring and ending with the mature

leaf. The time required for the full development of the leaf is one and a half to two months, or from the first of May to the middle or latter part of June. A goodly amount of each collection was dehydrated in Schultze's dehydrating apparatus and then put in absolute alcohol. In connection with the material as above described a large part of each collection intended for coarser work was placed directly in alcohol. In addition to the supply of alcoholic material a number of young thrifty sprouts were taken from the woods in September and placed in pots in the green-house with the hope of at least inducing an early development of leaves for histological and dynamical study. This experiment was quite successful and leaves both on the old branches and on new shoots sent up from the roots afforded ample supply of material throughout the latter part of winter and early spring for all necessary purposes. The young sprouts developed from the roots were the ones on which the observations on leaf movement as above described were made. The observations were not made, however, until after the leaves had attained almost if not entirely their full development. I also undertook to secure growing material from seeds, but on account of defects in the seed obtained the experiment was unsuccessful.

In the imbedding work, the paraffin method as described by Moll [1] of Groningen, Holland, was used. It was, however, found necessary to modify the method in some respects in order to obtain the best results. The most perfect infiltrations were obtained by subjecting the tissues while in pure turpentine to a temperature of from 40–45° C. for several hours. In all cases the fresh material taken from the green-house supply and hardened in picric or chromic acid gave the best results. Very little staining was done, but where undertaken haematoxylin was found to be the most satisfactory.

The mature pulvinus is composed of parenchyma, collenchyma, bast and woody tissue. The parenchyma is probably of first importance, since by changes in its turgescence the movements of the leaf are produced. The collenchyma, which in the petiole comprises the layer of cells immediately under the epidermis, is poorly if at all developed in the pul-

[1] The application of the paraffin imbedding method in botany. Botanical Gazette **13**: 5. 1888.

vinus. The bast which occupies the outer portion of the fibrovascular region forms a complete ring of closely set thick walled cells, and together with the woody tissues evidently constitutes the fulcrum or negative element in producing the leaf movement. By the use of the phloroglucin [2] test for lignin it was found that in the petiole the wood-cells, scalariform vessels and bast were highly lignified, while in the pulvinus only the scalariform vessels with some traces in the wood-cells gave the lignin reaction. The bast in the pulvinus was entirely unlignified and seemed to be much more easily macerated by the acid used in the test than in other parts. In the pulvinus the bast is much more closely packed around the woody tissue, the sieve-tubes and phloem parenchyma being less prominent than in the petiole. The position of these various tissues will be seen by an examination of figs. 4–12 inclusive, plate XX, which are intended, however, to show chiefly the changes in position of the fibrovascular bundles as they pass through the pulvinus. Fig. 4 is from a transverse section made at about the middle point of the petiole. The fibrovascular [3] portions occupy a single completed ring surrounding a centrally placed mass of parenchyma. In fig. 5, which is from a transverse section immediately below the upper pulvinus, the fibrovascular part is divided into two complete rings, in the larger of which there is evidence of still farther subdivision. Figs. 6–11 inclusive are from transverse sections through the upper pulvinus about equally distant from each other from the base to the top. In fig. 6, which is from the lowest section in the series, there is still more evidence of subdivision than in fig. 5; the peripheral parenchyma is more prominent, and the bast is seen to be slightly closer to the woody portions. In figs. 7–11 inclusive the peripheral parenchyma is the prominent feature. The greater diameter of the parenchyma cells seems to be at right angles to the longer axis of the petiole. In fig. 7 the fibrovascular portion is indefinitely and irregularly divided, while in figs. 8, 9 and 10 there seems to be a rearrangement of parts culminating in fig. 10 in three distinct bundles arranged as nearly as possible in a single plane, with the bast tissues closely packed around the woody portions. This is evidently the point of greatest flexure in the

[2] Goodale's Physiological Botany, 14.
[3] See explanation of plates, for lettering of drawings.

pulvinus. Fig. 11 shows the divisions of the fibrovascular parts as they enter the lamina of the leaf. At point *v* is shown a portion of a longitudinal section of one of the veins of the lamina. Fig. 12 is from a dorsiventral median longitudinal section of the upper pulvinus, point *x* being the lower and point *y* the upper end. In this section the fibrovascular portions appear only in a single line as they pass through the pulvinus.

From an examination of the nine drawings just explained it is evident that the fibrovascular bundles, which in the petiole are arranged in a single completed ring, are rearranged as they enter the pulvinus in a plane corresponding with that of the lamina of the leaf, thus offering the least resistance to vertical movement.

Francis Darwin[4] describes the first appearance of the pulvinus in the cotyledons of seedlings of Oxalis corniculata as a transverse zone of longitudinally compressed parenchyma cells. This transverse zone of cells he says makes its appearance about the second day of germination. In the plant under study it is possible to demonstrate leaves in the unopened winter buds of much less development than in the case cited by Darwin. By means of serial longitudinal sections of leaf buds passing dorsiventrally through the leaf petioles, leaves were found in which no evident trace of a pulvinus could be made out. This is true, however, only of the most minute traces of leaves; that is, leaves in which no differentiation into lamina and petiole could be made. In these embryonic leaves the first appearance of the pulvinus may be demonstrated. The pulvinus, as I believe, comprises in the broadest sense simply a continuation of the mesophyll tissue of the lamina down the petiole of the leaf. More carefully stated, it is an enlargement of parenchyma tissue at the upper end of the petiole corresponding both in development and structure with the loose parenchyma of the lamina of the leaf. It is a well known fact that all gradations of connection between the stipules[5] and the lamina of the leaf in various plants can be traced. The stipules may be a part of the lamina, or they may be only partially separated from it leaving a winged petiole, or the petiole may be naked as in the case of Cercis Canadensis leaving the

[4]The Power of Movement in Plants 119. 1881.
[5]Gray's Botanical Text Book, sixth edition, 1: 105–107.

stipules entirely distinct. With equal propriety a portion of the leaf lamina may remain in connection with the petiole and by special modification be changed into an organ for the production of motion. By means of dorsiventral longitudinal sections of the smallest leaves in which a distinction of parts could be made, the structure of the leaf, with the exception of a layer of epidermal cells along the dorsal (lower side when the leaf is expanded) surface together with a few parenchyma cells, was found to be uniform throughout. The next stage of development examined showed traces of scalariform vessels with evident parenchyma in both petiole and lamina. In the largest leaf which could be obtained from an unopened leaf-bud the parenchyma and fibrovascular portions of the petiole and lamina were found to be well developed and at a point in the petiole near the base of the lamina were to be seen a number of parenchyma cells showing evident irregular cell division. This irregular cell division I consider as the first appearance of the pulvinus. It corresponds closely with that taking place in the increasing mesophyll tissue of the lamina of the leaf and is in fact connected with it. Examination of more advanced leaves shows only an increase in number of these irregular cells until the mature pulvinus is reached which is composed in the main of loose irregular parenchyma. In contrasting the first appearance of the motile organ in the plant under study with that noted by Darwin in the case of Oxalis corniculata, I should say that while he observes the first appearance of the zone of cells which is to become the pulvinus from the fact of the transverse regularity of the cells, the exact opposite is true in the case of Cercis Canadensis, the first appearance of the pulvinus becoming evident from the fact of the irregularity of the cell division as contrasted with the regular cell division in the remaining portion of the petiole.

In summary it may be said that the pulvinus of Cercis Canadensis consists in the mature form of collenchyma, parenchyma, bast and woody tissue so arranged as to produce with the least expenditure of energy on the part of the plant under the influence of light a daily movement in the leaf lamina of nearly one hundred degrees. This motile organ is to be considered as a development through multiplication by irregular cell division of a portion of the parenchyma tissue at the upper end of the petiole, and moreover the development

of these irregular cells is seemingly in nowise essentially different either in time or character from that taking place in the mesophyll tissue of the lamina of the leaf.

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EXPLANATION OF PLATES XIX AND XX.

Plate XIX.—Cercis Canadensis as affected by light.—Fig. 1. Position of leaves at 3 o'clock A. M.—Fig. 2. Position of leaves at 8 o'clock A. M.

Plate XX.—External and sectional views of petiole and pulvinus of mature leaf.—Fig. 3, × 1½; Figs. 4-11, × 30; Fig. 12, × 12. *a*, epidermis; *b*, collenchyma; *c*, peripheral parenchyma; *d*, bast; *e*, sieve tubes and phloem parenchyma; *f*, scalariform vessels and wood cells; *g*, pith parenchyma; *v*, portion of long. section of vein of leaf lamina; *x*, lower end of pulvinus; *y*, upper end of pulvinus. All drawings of sections were made with camera lucida.—Fig. 3. Upper surface of mature pulvinus.—Fig. 4. Trans. section at middle point of petiole.—Fig. 5. Trans. section of petiole immediately below the base of the pulvinus.—Figs. 6-11. Trans. sections approximately 1^{mm} apart, from lower to upper end of upper pulvinus.—Fig. 12. Median dorsiventral long. section of mature upper pulvinus.

WRIGHT on CERCIS.

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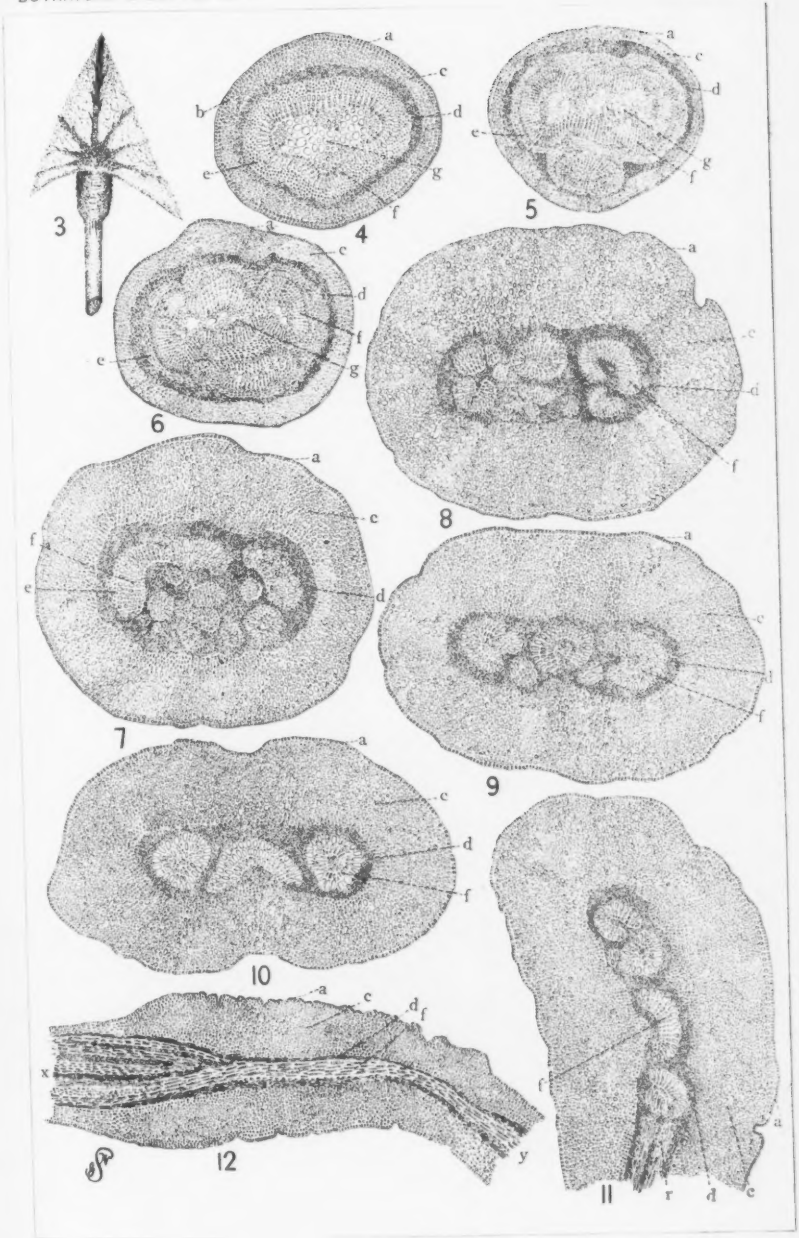

WRIGHT on CERCIS.

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Thomas Morong.

WALTER DEANE.

It is with feelings of sadness and regret that we are called upon to record the death of another of the older botanists, who are far too rapidly passing away from us. Dr. Thomas Morong belonged to the old school of systematic botanists, and during his life rendered an important service to science. His botanical career was unique in many ways. Though a clergyman by profession, he always pursued with undying enthusiasm his botanical studies in the face of many difficulties incident to the duties of a country minister, and late in life he abandoned entirely his profession to give himself up without restraint to the study of systematic botany in those branches to which he had always given his especial attention.

Thomas Morong was the son of Thomas Morong of Salem, Mass., and Jane C. Travers of Newmarket, Md. He was the eldest of four boys, and was born in Cahawba, Ala., Apr. 15, 1827, but as his father, who kept a store and owned a plantation, died when young Thomas was fifteen years old, the family moved north and settled in Woburn, Mass. Here he attended Warren Academy, and, part of the time, Hathaway's boarding school in Medford near by. He received a preparatory education at these two schools, and went to Amherst, where he was graduated in 1848, and on Aug. 24th of this year he married Mary L. Bennett, daughter of Rev. Joseph Bennett of Woburn, Mass.

He then entered the Harvard Law School, and for a time was a student in the office of Judge G. W. Warren of Charlestown, but the practice of the law being distasteful to him, he did not complete his studies. He then decided to enter the ministry, and accordingly went to Andover Theological Seminary, completing his course in 1853. He was ordained as a Congregational minister at Pepperell, Mass., Apr. 12, 1854, and from that time till 1888 he had charge of various parishes. In 1876 he went to Ashland, Mass., to supply the pulpit at the Congregational church. He was installed as pastor in 1878, and there he remained among his people, much beloved by them, for ten years.

Dr. Morong early acquired a strong taste for botanical pur-

suits, and as early as 1861 he built a greenhouse with his own hands and stocked it with plants. For two winters he had a class in botany in Ashland, and he was always ready to take his friends on a tramp, and instruct them in the secrets of the plant world and of nature generally, in a most delightful and unassuming manner, as those who have been with him abundantly testify. Through his own collecting and by purchase he acquired a large herbarium of North American phænogams, which was especially rich in aquatics. He always had a preference for flowering water plants, and in this branch he was an ardent student, besides having a wide knowledge of botany in general. He was preëminently a field-botanist, and it was a familiar sight to see him tramping off to his favorite ponds and streams, armed with his box and dredge. His keen observation, mature judgment, and wide knowledge of his subject combined to produce work of the highest order, and Dr. Morong holds a most honorable position as a systematic botanist.

During the botanical expeditions which he made from time to time he studied the flora of many of the eastern states, and his name is familiar in almost all of our local floras, as well as in our leading botanical papers, which are enriched by his valuable notes especially on the aquatic vegetation. The order to which he gave the most attention was the Naiadaceæ, and his name will always be associated with the genus Potamogeton, one of the most difficult, but to him most fascinating of studies. Not only did he investigate these plants thoroughly in their native haunts in pond, river and stream, but he carried on an extensive correspondence with American and European botanists in regard to them. It is a matter of congratulation that after so many years of honest, conscientious work, he at last published in March, 1893, in the Memoirs of the Torrey Botanical Club, "The Naiadaceæ of North America" with illustrations of every species. This work attracted much attention, and is a fitting monument to the author who died so soon after its publication.

In 1888, Dr. Morong carried out a plan which was to change completely the current of his life. This move of his showed clearly his ruling passion. He often had said to his confidential friends that he must do something for science, and he longed to go to South America and collect plants through the great water-ways that intersect the country in

every direction. He resigned his pastoral charge, collected a sum of money through the Torrey Botanical Club of New York, and a few kind friends, and on July 30, 1888, followed by the good wishes of his towns-people who presented him with a purse of money, he embarked on board the sailing vessel, Evie J. Ray, laden with lumber, for Buenos Ayres. He reached his destination in just ten weeks, and after a short stay in Argentina to perfect his plans, he went to Asuncion, Paraguay. Here he collected the rich and varied flora of this region till July, 1890. His enthusiasm was unabated, and though alone and unaided he sent back to the Columbia College Herbarium in New York about 900 species of phaenogamous plants, besides many ferns and mosses.

During his stay in Paraguay he went as naturalist on an exploring expedition up the Pilcomayo river, in the interest of the Paraguay Land Company. This trip of 400 miles into the heart of the Chaco wilderness, on a small flat-bottomed steamer was full of adventures with the wild natives and wilder jaguars, but Dr. Morong returned safely after an absence of six months to Asuncion with a large collection of valuable plants, consisting of about 2,500 specimens, including some 225 species, many of them new to science. As an illustration of the many difficulties to be overcome on the expedition, he writes the following: "We came upon a cataract of which nobody had ever heard, with a fall of five or six feet of water, and steep banks fifteen or twenty feet high each side of it. At first we thought this a 'stumper,' but finally we dug away an ascending plane on one side, and actually pulled the steamer, weighing five or six tons, up the falls by land." In July, 1890, he returned to Buenos Ayres, and after a considerable delay owing to the revolution raging at that time, he sailed around the cape to Valparaiso, Chili, where he met his brother after forty years of separation. From there he went to his brother's home at Caldera, in northern Chili, and for some weeks he revelled in the rich flora of the Atacama desert. He was astonished at the extraordinary sand, plain and hill flora of this remarkable region. "Strange, isn't it, that a desert should yield many flowering plants," he writes. On Oct. 25, 1890, he sailed for home, by way of the isthmus, reaching New York the following month. He had collected during his trip, entirely with his own hands, 20,000 specimens of plants, a collection rendered doubly valuable by his copious field notes.

On his return home, Dr. Morong accepted the position of curator of the herbarium at Columbia College, and there, for three years, among congenial friends and co-workers, he devoted himself heart and soul to his botanical studies. In 1892, in conjunction with Dr. N. L. Britton, he published the results of his work in Paraguay, "An Enumeration of the Plants collected by Dr. Thomas Morong in Paraguay, 1888–1890." This work is a valuable contribution to science, and it is pleasing to see that Dr. Britton has shown his appreciation for Dr. Morong's labors by dedicating many new species to him. His life in New York was a busy one. Besides the duties of his position and the original researches he was always carrying on in the herbarium, he was constantly writing for the various botanical journals. He conducted classes in botany at Barnard College, New York, and delivered lectures at the Biological Laboratory at Cold Spring Harbor, Long Island, at the Brooklyn Institute and elsewhere.

In December, 1893, he went south to shake off a bad cough which he had contracted in New York, but it was of no avail. Reaching Jacksonville, Fla., he was obliged to go to St. Luke's Hospital, and there he stayed till the middle of April, hoping against hope, for consumption had set in. The few lines which he was able to write showed his old enthusiasm, and his determination to recover. He returned north with much difficulty in April and went to his son's house in Boston where he died April 26, 1894, at the age of sixty-seven years. The funeral services were held in Woburn, and he was buried there in the family lot. His death was a peaceful ending to a well-spent life.

Cambridge, Mass.

The influence of mechanical resistance on the development and life-period of cells.

FREDERICK C. NEWCOMBE.

(Concluded from p. 199.)

The effect of external mechanical resistance on the duration of the life-period of cells.

The fact that meristem in growing points, in the cambium and in zones of plants that increase by intercalary growth, may preserve its functional capability for many weeks while the tissue is held in an apparently inactive condition by gypsum casts has already been shown. From what is now to follow it will appear that the life-period of cells may be prolonged if their growth or that of neighboring cells is mechanically restrained.

After young aerial shoots of Juncus effusus had been, without detaching them from the rhizome, kept in gypsum casts for some time, the longest period being eleven weeks, that part of the shoot above the meristem showed a thicker living peripheral zone of tissue than was there present when the shoot was put into gypsum, and thicker than normally occurs at any time in this stem. The greater thickness was not dependent on a radial elongation of cells so much as on an increase by two of the number of circular rows of cells over the number normally found. If growth had not been interfered with, the shoot in elongating and enlarging radially would have increased the size of its dead central mass of stellate cells by first the branching and then the death of these two innermost rows of living cells. As it was, the central cylinder of cells that were dead when the cast was applied had been crushed together by the inward push of the newly formed cells while the latter had lived much beyond their usual life-period.

Two shoots of Equisetum limosum that had grown not more than 3^{cm} or 4^{cm} above the ground and whose internodes had not nearly completed their elongation were so encased in gypsum that the apex of the stem was left free. Thus they grew for three weeks reaching a height averaging over 20^{cm}. The stems increased but slightly in diameter in this time and the

internodes within the casts did not elongate. In these internodes the intercarinal canals had not formed in one plant, their place being occupied by living cells, while in the other plant but two or three cells had died in each of those positions. Above and below the limits of the casts the canals were of large size. It need hardly be mentioned that normally these canals arise mostly by the destruction of cells. Similar preparations to the foregoing but in which the stems were left in the gypsum twice as long, had, when examined, canals within as well as without the casts.

A young plant of Zea mais the lower part of whose stem was so encased in gypsum as to prevent elongation of one of its internodes to one-third of what it would have been, had not within the cast thirty-seven days afterwards formed the usual lysigenous canals in the vascular bundles, the thin-walled cells being there undisturbed and living, while in other parts of the stem they were destroyed. Here since there was but slight constriction of stem made by the cast, the prolongation of the life of the cells in question is probably to be referred to the checking of the elongation of the internode.

The growth of the leaves of Allium cepa is not easily confined by a surrounding cast; since, when the tip of the leaf is left free the organ glides through the gypsum because of the very smooth surface of the former. This gliding can be prevented, however, by bending the leaf into a zigzag course and so fixing it before the gypsum is poured on. By pursuing such a method young leaves have been encased and the parts within casts have been kept from becoming inflated while all cells remained alive. In the same leaves, above and below the casts the normal inflation took place two or three days after the casts were applied. The longest period that the central cells of such leaves within casts have been kept alive is fifteen days, or from eleven to twelve days after such cells had died in parts outside the casts.

Sachs[14] has shown that if an onion is germinated in the dark, its leaves will not become hollow. Histologically this means that the normally assimilating cells of the periphery will not be developed in their usual H-palisade form, when light is absent. It is at the time of the rapid extension of the peripheral cells of the young leaf to the dimensions of these assimilating cells that the central hyaline mass of the

[14] Sachs: Ueber den Einfluss des Tageslichtes auf Neubildung und Entfaltung verschiedener Planzenorgane. Botanische Zeitung, Beilage. 1863.

leaf is torn and the leaf changes from the thin, sword-shape to the inflated. The cast effects what darkness effects; in both cases the small peripheral cells remain undeveloped. But casts better than darkness preserve the life of the central, hyaline cells, since the larger etiolated leaves always undergo considerable peripheral extension and always show a narrow cavity lined by fragments of destroyed cells. That this central part of the leaf has not been kept alive longer than about two weeks is accounted for by the fact that at about that time the leaf, which is plano-convex, in its effort to expand folds inward on its flat side, thus crushing the delicate central cells.

The petiole of Ricinus communis when unextended contains no central cavity, but a wide one extended. By applying casts the death of this central mass of tissue has been prevented for about three weeks longer within than outside the casts.

With the rhizome of Triticum repens a similar result was obtained, the internodes being allowed to reach not one-half their normal size, and the cavity appearing above and below the casts before appearing within.

Before elongation was complete, casts were put around the stems of Caltha palustris, Lamium garganicum, Urtica dioica and Vicia faba. All of these plants form central cavities during elongation or at its termination, partly by the schizogenous partly by the lysigenous method. All of them have preserved alive the pith of those parts of the stem within the casts longer than in the parts outside the casts. The period of this preservation was not determined for any species; nor is it a matter probably of much moment since the duration of the period depends largely on the time of application of the cast relative to the development of the part concerned. The younger the organ is when enclosed in gypsum, the longer will its cells remain alive. It should be stated that the longest period of experiment was that in the case of Vicia faba, in which several individuals were found with pith wholly living within the casts 116 days after it would have died normally. In the third internode above the cotyledons, the internode used in these experiments, the cavity normally appears some time before elongation is ended. The plants in which the pith had been preserved for 116 days longer than usual had reached nearly a meter in height and had seed-pods half grown.

Similarly to the cells of the pith, the life-period of the cortical cells has also been prolonged. Lamium garganicum, Urtica dioica and Vicia faba have shown dead cells in the cortex outside the limits of the casts, when within the casts all cells have remained alive.

There have come under my observation two species of plants in which, sometimes but not always, cortical cells are crushed within the casts before any dead ones appear outside the casts. These plants are Ricinus communis and Dahlia variabilis. This result is apparently brought about by the growth of the fibrovascular zone, the turgor there present being sufficient to cause the less resistant cells of the cortex to collapse, whereas similar cells outside the limits of the casts live for some time longer, though the tissue which they form becomes looser and looser by the separation of cells.

In all of the foregoing cases in which the life-period of cells has been more than normally prolonged, the cells were prevented from attaining their full size by confining their growth before they were fully extended. But in certain cases the death of cells may be deferred by checking the growth of surrounding tissue after the cells in question have reached their full extension. In Sambucus nigra and Helianthus tuberosus, for instance, where the pith lives for several weeks after secondary growth has begun, a cast applied after the pith has grown to its definitive size will preserve the pith alive for several weeks after it dies above and below the limits of the cast.

Summary.

I. *Meristematic tissue of growing points, intercalary zones and cambium will preserve for a considerable period its functional capability when growth is prevented by an external mechanical resistance.*

II. *When in such meristematic tissue growth is checked by mechanical resistance, the tissue remains apparently unaltered; the cells do not divide, nor the walls become thicker, nor the composition of the walls undergo change.*

Especial attention may be called to the biological significance of the two facts just stated, and to the resemblance to what takes place when growth ceases because of cold or insufficient moisture. It is manifestly to the interest of the plant-organism not only that the life of meristematic tissue should be retained but that the primary condition of this tis-

sue should be retained, instead of the passing of such tissue over into a permanent state where growth could not be resumed when the obstacle to growth should be removed.

If it should be found—what neither Pfeffer, Krabbe nor I have once observed—that in some plants the cell-walls of the meristem become slightly thicker during the enforced rest of this tissue, as Krüger[15] found thickenings to arise in the radial walls of the cambium of some plants during the winter rest, the importance of the biological truth would not be altered, that the meristem retains its functional capability.

That the cell-contents may change during mechanical resistance was shown by Pfeffer[16] in the case of the primary root of Vicia faba, where there was a considerable rise of turgor after the root was enclosed in a gypsum cast. This rise of turgor does not take place in all plants, as Pfeffer showed.

III. *The period between the formation of a cell and the arrival at its definitive condition is lengthened by an external resistance preventing or impeding growth.*

Under this general statement is included a group of phenomena the details of which may be the better emphasized by greater individual prominence, such as the following:

1. *The zone of elongation in roots and stems passes more slowly into its definitive length.*

2. *Differentiation of the fundamental parenchyma into collenchyma, sclerenchyma and sclerenchymatous parenchyma proceeds more slowly.*

3. *All the thick-walled and lignified elements of the bundles develop more slowly.*

It has already been stated that De Vries discovered this for elements of the xylem. The observations here recorded show that it holds true for the hard bast also.

4. *The formation of cork is deferred.*

This statement is in accord with the results obtained with the three plants under experiment and also with Gerber's[17] results in placing ligatures about stems. Since, as has been shown in this article and in the investigations of others, cells do not divide under pressure till they have reached or nearly

[15] Krüger: Ueber die Wandverdickungen der Cambiumzellen. Botanische Zeitung **50:** 663. 1892.

[16] Pfeffer: Druck-und Arbeitsleistung, 65.

[17] Gerber: Ueber die jährliche Kork-production im Oberflächen-periderm einiger Bäume. Inaug. Diss. Halle 1884.

reached their normal dimensions, and since cork-formation must be accomplished by extension and division of cells, it follows as a probability that cork-formation is delayed by pressure because of the mechanical resistance to cell-extension. But since cork-formation is attended by the death of externally lying cells, it is easily seen that soon after the formation of the phellogen, an external ligature or gypsum band will exert no immediate pressure in those cases where the phellogen is some distance within the periphery of the stem, simply because of the contraction of the dying tissue between the phellogen and the external ligature or band. Thus it seems probable that if external resistance is applied early enough to prevent the normal extension of the cells in which the phellogen usually appears, the formation of cork may be indefinitely postponed. If however the cells normally giving rise to the phellogen attain their full dimensions before the external resistance is applied we may expect the phellogen to be formed and cork-formation to proceed more or less slowly according to the greater or less vitality displayed by the cells external to the phellogen, and also according to the depth of phellogen within the cortex.

In this connection it is worth noting that Krabbe[18] found cork to arise deep within the cortex when a very great pressure was applied to the trunks of trees, this phenomenon being abnormal. This is certainly a regulatory act performed by the plant, but whether to regard it as a means of furnishing more room for the growth of the cambium cannot be decided with the lack of detail touching the accompanying phenomena as given by Krabbe. It may be mentioned however that Melianthus major, though the cork appears within an enveloping cast more tardily than outside of it, eventually frees itself completely from the resistance of the cast by the very act of cork-formation, the activity of the cambium from that time forward being usually great.

IV. *Under the pressure of a mechanical resistance cells reach their permanent condition with smaller size and thinner walls than normal.*

V. *Cells which usually die early have their life-period prolonged when their full extension or that of properly related adjacent cells is prevented by an external mechanical resistance.*

As appears from the narrative of the experimental part of

[18] Krabbe: Ueber das Wachsthum des Verdickungsringes, etc. l. c.

this article, the statement just made is founded principally on the behavior of the cells of the fundamental parenchyma. It was found in all cases where cells normally dying early were kept from reaching their full size that their life-period was extended. In certain cases also it was found that the pith of plants will live longer than usual if a gypsum cast is put around the stem after the pith has reached its full size, the cast, however, preventing the surrounding tissues of the stem from enlarging. It is probable that in the latter case, the pith lives because of the regulatory action of the plant, the usual more peripheral tissues not being formed, new duties are laid upon the pith. Such regulatory action accounts for the phenomenon discovered by De Vries[19] in Pelargonium zonale. In this case the flower axis bore among the flower-buds a vegetative bud which developed into a shoot, and the flower axis instead of withering as usual lived to function as a vegetative axis.

It is probable also that in the first group of experiments in which the cells were not allowed to reach their normal size that the same cause operated to prolong the life-period. Yet this was not in all cases the important cause. In the shoots of *Juncus* the cells remained alive though no greater demand was made upon them for transport of material nor for other function that can be thought of; the same could probably be said for the stems of Equisetum and the leaves of Allium enclosed in casts. In the case of the leaves of Allium when grown in darkness, we have the direct evidence that it is not the use of the central cells for purposes of transport that keeps them alive. In such cases it is probable the cells in question remain alive longer than normally because the conditions for their existence are not so unfavorable; that is, they live because the surrounding tissues are not allowed by their growth to pull these cells apart and thus bring them into unfavorable conditions. This question will be farther considered in a future article.

The experiments recorded in this paper have been scarcely extended enough in time to demonstrate the extension of the life-period of the elements of the fibrovascular bundle. That these elements also live longer than normally when surrounding tissues are not allowed to grow may be certainly inferred

[19]De Vries: Ueber abnormale Entstehung secundärer Gewebe. Jahrb. f. wiss Bot. **22**:—1891.

from the examples which all have noticed of vines twining about trees or of ligatures left unintentionally for years about trees. Since the elements of the bundle of woody plants normally live but a few years, it follows that beneath a ligature, such as those just mentioned, which has prevented radial extension in a tree for many years, the elements of the bundles must live longer than normally, otherwise we should have the whole zone dying and the stem above the ligature also dying.

VI. *If during primary or early secondary extension in a dicotyledonous stem, with pith of not great resistance, radial growth be prevented by external mechanical means, there will follow a displacement of the fascicular zone toward the axis of the stem, caused principally by the extension of the cortical cells. Later, however, the cortex will be crowded back by the growth of the fascicular zone.*

VII. *When an external pressure is great enough to prevent the derivatives of the cambium from attaining their normal size, the cambium will still continue to form new cells. This is an expression of the fact that the power of extension in the cambium is greater than that in derivatives of the cambium some distance removed from it.*

University of Michigan, Ann Arbor.

New mosses of North America. V.

F. RENAULD AND J. CARDOT.

WITH PLATES XXI AND XXII.

Archidium Hallii Aust. var. **minus.**—Smaller than the type, from which it differs besides in the leaves shorter and the costa percurrent or shortly excurrent.

Louisiana: near Mandeville (*A. B. Langlois*, 1892).

Dicranella leptotrichoides.—Resembling in habit *Leptotrichum tortile.* Dioecious, small, loosely cespitose, green. Stems short, erect, simple, 2–5^{mm} long. Leaves erect or subsecund, lanceolate, acuminate, subacute or rather obtuse at the apex, quite entire, borders plane or partly revolute; costa stout, percurrent; cells of the areolation oblong or sublinear, shorter looser and subrectangular below. Perichaetial bracts scarcely different, a little longer. Pedicel 5–7^{mm} long, yellowish when young, afterwards reddish. Capsule small, erect, symmetric, ovate-oblong, scarcely constricted under the orifice when dry; lid equalling the sporangium, long and obliquely subulate-rostrate. Peristome purple, teeth trabeculate, striolate lengthwise, cleft to below the middle into 2–3 subulate legs, granulose and partly connected; annulus very broad, deciduous, of 2–3 rows of cells. Male plant unknown.

Louisiana: on slopes, Rivière Tchiffouté, Abita Springs, Covington, Fontainebleau near Mandeville (*A. B. Langlois*, 1891–1892). We have also specimens collected near Mobile, Alabama, by Sullivant, and distributed as *Trichostomum tenue.*

Closely allied to *D. Tonduzii* Ren. et Card. from Costa Rica; but distinguished by the leaves straight when dry and the areolation different.

Fissidens falcatulus.—Very small, gregarious, yellowish green. Stems rather rigid, plumulose, 2–4^{mm} long. Leaves 4–8 pairs, falcate-secund and rigid when dry, linear-lanceolate, acute or subapiculate; vaginant lamina about one-half length, narrowly bordered, dorsal lamina not bordered, tapering below, apical lamina without a border, subentire or minutely crenulate at the apex; costa pale, subpercurrent; areolation pellucid, cells hexagonal. Fruit unknown.

Louisiana: on bark of trees, Catahoulou, near Mandeville and bayou Alexandre (*A. B. Langlois*, 1890–1891).

Very near to *F. exiguus* Sulliv., from which it is distinguishable by the rigid habit, the leaves narrower and falcate-secund when dry, and the more pellucid areolation.

Physcomitrium turbinatum Brid. var. **crassipes.** (*P. Hookeri* var. *serratum* Ren. et Card. *Musc. Am. sept., p. 31*).—Pedicel short (4–6^{mm}), thick; capsule deoperculate, cup-shaped.

Oregon (herb. Lesquereux): Sandy river (*L. F. Henderson*), Willamette river (*Th. Howell*).

Bryum bimum Schreb. var. **atrotheca.**—Capsule black-red; leaves scarcely denticulate or quite entire at the point.

Newfoundland (*Rev. A. C. Waghorne*, 1892).

Timmia Austriaca Hedw. var. **brevifolia.**—Differing from the typical form by the stems shorter and the leaves more crowded, shorter and erect-imbricate, scarcely flexuous when dry.

Colorado: Springdale, Boulder Co. (*Marie Holzinger*, 1892. Comm. J. M. Holzinger).

Pylaisia polyantha Sch. var. **Coloradensis.**—Distinct from the type in the green tint and the cells shorter, very chlorophyllose.

Colorado: Springdale, Boulder co. (*Marie Holzinger*, 1892, Comm. J. M. Holzinger).

Brachythecium salebrosum Sch. var. **Waghornei.**—A peculiar form, distinguishable from the type by the tufts very dense, the stems erect, turgid, not radiculose, the leaves more crowded, imbricate, and the lid mamillate. Differs from the allied *B. mamilligerum* Kindb. in the leaves imbricate, not patulous when dry, and the stems not radiculose. Much smaller than *B. turgidum* Hartm.—Monœcious!

Labrador: Battle Harbor (*Rev. A. C. Waghorne*, 1891. Comm. Rev. C. H. Demetrio).

Brachythecium suberythrorrhizon.—Monœcious, intricate-cespitose, yellowish-green, facies of *B. velutinum.* Stems creeping, radicose, sparingly branching, branches procumbent. Leaves subhomomallous, oblong-lanceolate, long narrowly acuminate, bi–tri-plicate, sharply serrate all around; borders plane or partly revolute, costa vanishing above the middle, sometimes forked and shorter; areolation rather loose, pellucid, cells rhomboidal-linear, the alar quadrate, sub-obscure. Perichaetial bracts lanceolate, long acuminate-subulate, acumen serrate. Pedicel smooth, reddish, 10–12^{mm} long. Capsule suberect, turgid-ovate, not or scarcely constricted

below the mouth when dry; lid unknown. Teeth of the peristome yellowish, triangular-lanceolate, segments narrow, split along the divisural line, cilia 1 or 2, long, filiform.

Colorado: Springdale, Boulder co. (*Marie Holzinger*, 1892. Comm. J. M. Holzinger).

Nearly allied to *B. erythrorrhizon* Sch., from which it differs in the narrower leaves and the looser areolation.

Brachythecium reflexum Sch. var. **Demetrii**. — Differs from the genuine form in the stronger habit, the thicker erect branches, and the broader softer leaves.

Labrador: Squaw Island (*Rev. A. C. Waghorne*, 1891. Comm. Rev. C. H. Demetrio).

Eurhynchium Sullivantii L. et J. var. **Holzingeri**.—Differs from the type in the branches shorter, generally obtuse, and the leaves broader and shorter acuminate.

District of Columbia: near Washington (*F. V. Coville*, 1889–1890. Comm. J. M. Holzinger).

Thamnium Holzingeri.—Green, slender, rather resembling in habit the small forms of *Isothecium myosuroides*. Primary stems creeping, stoloniform, secondary ascending or decumbent, more or less shrub-like, pinnate, branches complanate, generally attenuate. Lower stem leaves small, erect-spreading, from a broadly deltoid base ligulate-obtuse; costa vanishing about the base of the acumen; upper leaves larger, distichous, complanate, slightly asymmetric at the base, oblong-ligulate, obtuse or subobtuse, costa vanishing far from the apex, sometimes forking above; branch leaves smaller, with the costa shorter and the lower margin inflexed, the upper leaves acute; all the leaves plane and crenulate-serrate on the margins, coarsely and irregularly dentate at the apex; areolation parenchymatous, cells incrassate, short, chlorophyllose, roundish or subhexagonal above, ovate or oblong in the middle, sublinear below, the alar small, rather obscure, subquadrate or roundish. Inner perichaetial bracts subvaginant, oblong-lanceolate, long loriform-acuminate, serrulate, costa thin, cells narrower; vaginule covered with numerous long paraphyses. Pedicel smooth, reddish, short (6–9^{mm}). Capsule erect, oblong, subsymmetric, constricted under the orifice when dry, lid conic, obliquely beaked. Teeth of the peristome yellowish, lanceolate-acuminate, subulate, segments narrowly split along the divisural line, cilia 2, long, nodose. Seems to be dicœcious.

Oregon: Myrtle Point, Coos co. (*Rev. G. A. Holzinger*, 1892. Comm. J. M. Holzinger).

This fine little moss cannot be confounded with any other North American or European species. It rather resembles some small tropical species of the genus *Homalia* and *Porotrichum*, but is easily distinguished from these by the perfect peristome, with long cilia.

Amblystegium Holzingeri.—Loose, green or yellowish green. Stems depressed, irregularly branching. Leaves very loose, distant, patulous, ovate-lanceolate, broadly and obtusely acuminate, quite entire; costa generally simple, thin, vanishing above the middle, sometimes forked and shorter. Areolation rather loose, cells oblong or linear, flexuous, with the primordial utricle distinct, the alar shorter, looser. Perichaetial bracts oblong-lanceolate, acuminate, very entire, costate, more narrowly reticulate. Pedicel short, 6–8^{mm} long, reddish. Capsule inclined or subhorizontal, small, ovate, arcuate, much constricted below the mouth when dry, lip depressed, obtusely apiculate.

Virginia: bank of Potomac. District of Columbia: Rock Creek. (*J. M. Holzinger*, 1891–1892.)

Allied to *A. adnatum*, but easily distinguished by the short-acuminate and obtuse leaves, the generally simple costa, the looser and less numerous alar cells, the shorter capsule and the more depressed lid.

Hypnum giganteum Sch. var. **Labradorense.**—A notable variety, distinct from the type by the leaves larger and longer and the costa attenuate, vanishing rather far from the apex and often forking.

Labrador: Battle Harbor (*Rev. A. C. Waghorne*, 1892).

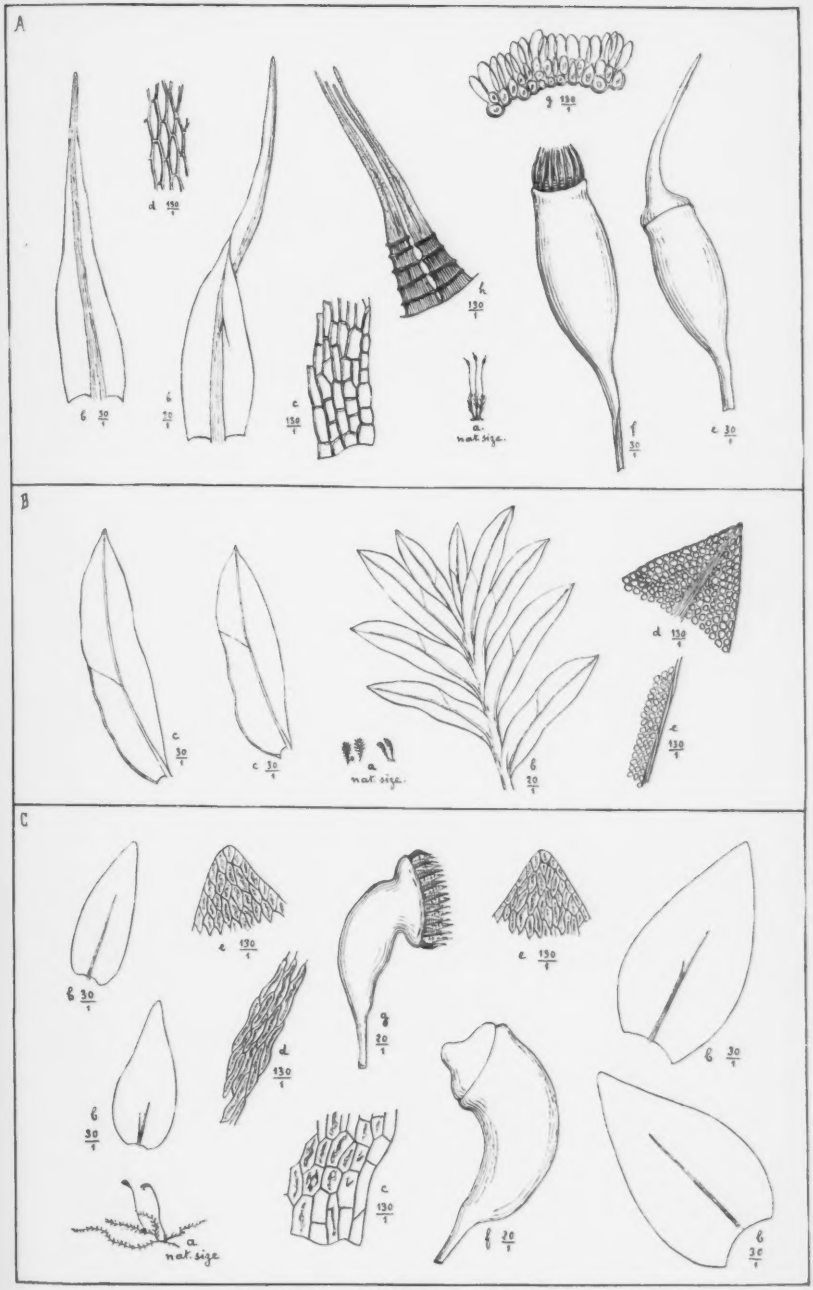
Vesoul and Stenay, France.

EXPLANATION OF PLATES XXI AND XXII.

All the figures magnified are drawn by means of Nachet's camera lucida.

PLATE XXI.—**A.** *Dicranella leptotrichoides.* *a*, entire plant; *b*, *b*, leaves; *c*, areolation of the basal borders of the same; *d*, do. in the middle; *e*, capsule with the lid; *f*, capsule deoperculate; *g*, portion of the annulus; *h*, two teeth of the peristome.—**B.** *Fissidens falcatulus.* *a*, entire plant; *b*, upper part of a stem; *c*, *c*, leaves; *d*, apex of a leaf; *e*, areolation of the margin of the vaginant lamina.—**C.** *Amblystegium Holzingeri.* *a*, entire plant; *b*, *b*, *b*, *b*, leaves; *c*, alar cells; *d*, areolation in the middle; *e*, *e*, areolation of the apex; *f*, capsule operculate; *g*, the same deoperculate.

PLATE XXII.—**A.** *Thamnium Holzingeri.* *a*, entire plant; *b*, portion of a branch; *c*, *c*, lower stem leaves; *d*, *d*, upper stem leaves; *e*, branch leaves; *f*, apex of a stem leaf; *g*, apex of a branch leaf; *h*, alar cells; *i*, areolation on the margin, in the middle; *j*, areolation of the apex; *k*, inner perichaetial bract; *l*, capsule with the lid; *m*, portion of the peristome.—**B.** *Brachythecium suberythrorrhizon.* *a*, entire plant; *b*, *b*, *b*, leaves; *c*, alar cells: *d*, *d*, point of the same; *e*, capsule deoperculate; *f*, leaf of *B. erythrorrhizon* Sch.



RENAULD and CARDOT on NEW MOSSES.

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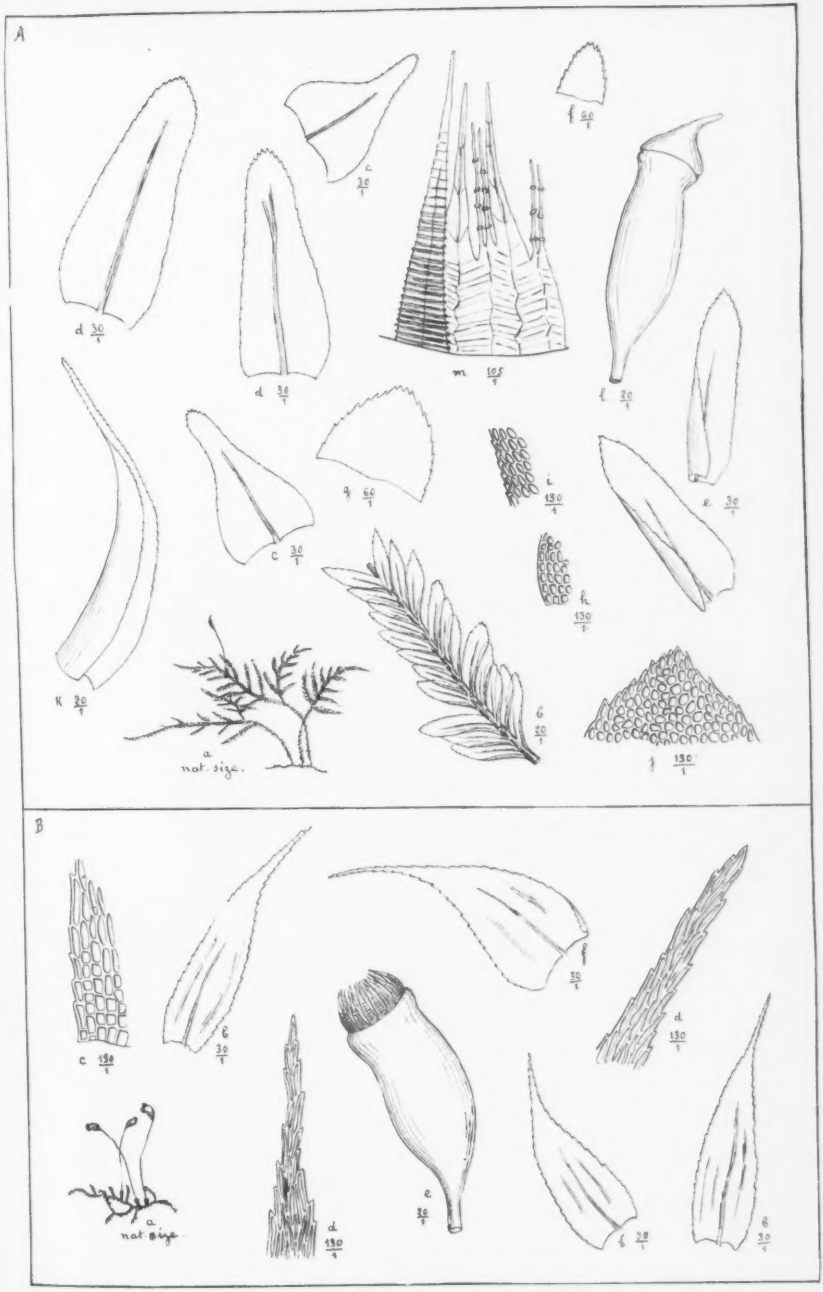

RENAULD and CARDOT on NEW MOSSES.

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Notes on Richardia Africana.

ERNEST WALKER.

Of the many abnormal "flowers" of Richardia Africana which have come under the writer's observation the most interesting departure from normal structure yet seen made its appearance a short time since in one of the green-houses among a lot of several hundred "callas."

In this monster the spathe and spadix while developing in the manner of an ordinary inflorescence were found at maturity to be independent, or disunited, and each on a stalk of its own.

The spathe was somewhat larger than usual, more spreading, and not at all convolute at the throat. Its stock or petiole was sheath-like from the spathe down to the base and clasped the scape which supported the bractless spadix almost in the same manner that the petiole clasps an ordinary "flower" stalk.

The white color and texture of the spathe extended for some distance down the free wavy margins of the petiole.

The spadix was normal otherwise except in having fewer ovaries than usual. At first it occupied the ordinary position in the spathe; but after a few days, owing to continued growth of its scape, it became elevated 4^{cm} above its usual position.

There was a coadnation at the base of the scape and petiole for 9^{cm} upward, but this involved only the posterior wall of the sheath while the anterior edges were free.

This self-analyzed inflorescence makes clear the morphological structure of the Richardia flower and peduncle. One writer has explained the scape as made up of "several leaf-stalks grown together in a bundle," but it now is evident that only one leaf is involved. The spadix is at the summit of a single much elongated internode of rhizome, to which in the normal inflorescence the sheathing leaf-stalk is adnate.

In the spadix itself there is complete suppression of bractlets to which the flowers are, however, theoretically axillary. Even keeping this in view it is not necessary to regard the scape as involving a number of leaf-stalks in its structure since if bractlets existed they would more likely be stalkless appendages rather than the free tips at the summits of long theoretical petioles.

This "flower" had a good opportunity to fertilize itself if this had been possible. In the hope of getting it to seed the stigmas were hand pollinated after about the third day. But in vain. After about three weeks the ovaries had developed considerably and attained about half size. Then they stopped growing and the spadix began to shrivel. The spathe withered earlier.

This result and experiments with several other plants convinced the writer that the flowers are proterogynous. Examination showed that the stigmas were receptive of pollen about three days before the pollen of the same spadix begins to fall, and when the pollen appears the stigmas are much shrunken.

Four flowering plants were set aside, and with due precautions, left to fertilize themselves. Although the ovaries began development they withered when about half grown. The "calla" is said rarely to produce seed in the green house. We now have in its proterogyny, the explanation.

The spathe is a specialization looking to cross fertilization, although its convolute and funnel-like base at first might seem nicely adapted for catching the pollen and bringing about self fertilization. It is likely this occurs, however, in Araceæ just in proportion as the spathe is reduced and the individual flowers on the spadix become hermaphrodite and complete.

In the Richardia there are on most of the older and larger leaves two gland-like bodies at the summit of the petiole where the basal lobes of the lamina join the leaf stalk. They look as if they might be nectar glands; but they are probably merely thickenings to strengthen the blade against tearing, when the plants are growing in running water, and occasionally submerged, as is the case in their native land.

While engaged in these observations it occurred to me to investigate the manner in which the pollen is forced out through the minute pores.

The anthers are almost sessile somewhat cuboidal bodies. Wood's "Class book" gives them as two-celled, but the cells being bilocellate they may be called four-celled. The locelli are vertical, oblong, thin-walled, and confluent above into a single tube, terminating in a minute pore through which the pollen is pressed.

The discharge of the pollen was found to be brought about by pressure caused by the gradual enlargement of the connec-

tive. In a young anther the connective is delicate and thin, making up about one-third the width of the anther. In old anthers it composes about two-thirds of the width, having become broad and plump as the cells decreased in size from the loss of their contents. All this takes place without any appreciable change in the size of the anther as a whole. The connective thus acts like a wedge between the cells. The sessile anthers being much crowded, growth of the connective results in a mutual pressure between the cells of one anther, and those of its neighbor.

The grains of pollen are smooth walled and slippery with mucilage, so under the pressure readily escape through the small pore. While within the cell the grains are semi-translucent but on escaping they become opaque white. The mucilage moistening their surface causes the grains to adhere together as they escape. Consequently the pollen is found in filamentous form. This is evidently with reference to transportation by some kind of living agent.

It is noticed that the summit of the anther through which the discharge tube leads is transversely thickened and quite firm. This is for the purpose of preventing rupture of the pore, and securing the discharge of pollen in the form of a filament, instead of a mass as would be the case were it not for the precaution nature has taken.

On cutting off the summit of the anther the relief to pressure results in the immediate discharge of the pollen in the form of cylindrical masses as large as the diameter of the locelli. Thus it is seen the contents of the anther cells are subjected to a considerable pressure, as necessary to secure the discharge of the pollen in the form of filaments as seen in the normal anther.

New Albany, Ind.

BRIEFER ARTICLES.

Olpitrichum, a new genus of mucedinous fungi.—WITH PLATE XXIII. —Among the fungi which are active in hastening the rot of the carpellary tissues of the fruit of *Gossypium* in the United States, when the cotton is mature and during wet weather, are several mucedinous fungi which are attractive from the whitish or dirty buff color of the loose mass of threads and spores. Two of these which are quite common are members of the genus *Rhinotrichum* Corda. They occur either separate or intermingled on the same boll. *R. macrosporum* Farlow is, perhaps, the more common of the two and is quite frequently of a sordid buff color and can thus be provisionally separated from the other species, *R. tenellum* B. & C., at times, before examination with the microscope. These two species are quite common in the vicinity of Auburn, Alabama, and I have found them in several other parts of the state.

When visiting Brundage, Ala., for the purpose of inspecting the condition of the cotton in that region, I collected a fungus on the bolls which I took upon superficial examination to be *R. tenellum*, from the fact that it resembled this species in color. It proved to be very different however, and the character of the basidia clearly separates it from the genus *Rhinotrichum*.

In *Rhinotrichum*[1] the sterile hyphæ are creeping, the fertile ones erect, their ends being denticulate to spiculigerous, the spores being borne on these acicular sterigmata. In this new genus, for which I propose the name *Olpitrichum*, instead of the ends of the fertile hyphæ being denticulate or spiculigerous, they bear well developed flask-shaped basidia, which are scattered over the surface of the terminal portion of the hypha, or are clustered irregularly or in rosettes. The genus may be characterized as follows:

Olpitrichum gen. nov.—Saprogenous. Sterile hyphæ creeping, septate, branched; fertile hyphæ erect, simple or little branched, septate. Near the apex provided with flask-shaped, fusoid, or enlarged basidia, irregularly scattered or gregarious, which may be branched or become proliferous, each bearing a single spore. Conidia ovoid-oblong, hyaline or pale colored. It is *Rhinotrichum* but with inflated basidia which are constricted at the point of union with the hypha. It bears much the same relation to *Rhinotrichum* that *Pachybasium*[2] does to *Verticil-*

[1]Corda, Icones Fung. **1**: 17. Saccardo, Syll. Fung. **4**: 91.
[2]Saccardo, Fung. Alger. Tahit. Gall. 6.—Syllog. Fung. **4**: 149.

lium. The basidia resemble somewhat those of *Cylindrodendrum*,[3] are less regular in form, while those of *Cylindrodendrum* are subopposite and sometimes whorled, and the conidia are strictly cylindrical.

Olpitrichum carpophilum sp. nov.[4]—Effuse, whitish. Fertile hyphæ hyaline, 3–7-septate, 90–180 × 4–6μ. Basidia flask-shaped or fusoid scattered, or grouped irregularly or in the form of rosettes, 10–15× 3–6μ. Conidia ovate or sometimes oblong or broadly elliptical, frequently with a minute apiculus at the base, hyaline, 25–30 × 16–25μ, or 16–25μ in diameter. On decaying carpels of *Gossypium herbaceum*, Brundage, Ala., Sept. 1891.

The characters of *O. carpophilum* are shown in plate XXIII, figures 1 to 4. *Rhinotrichum macrosporum* Farlow and *R. tenellum* B. & C. are also represented in the same plate. The spores of *R. macrosporum* Farl. measure 15–30 × 10–20μ, and those of *R. tenellum* B. & C. measure 6–12 × 10–20μ. The ends of the fruiting hyphæ or their branches are somewhat enlarged and denticulate or spiculigerous in *R. tenellum*. —GEORGE F. ATKINSON, *Botanical Department, Cornell University.*

EXPLANATION OF PLATE XXIII.—Figs. 1–4, *Olpitrichum carpophilum* Atkinson.—Figs. 5–8, *Rhinotrichum macrosporum* Farlow. Figs. 9–13, *R. tenellum*, B. & C. Figs. 4–7, 9–13 drawn to the same scale; 1–3, 8, and 14 drawn to the same and a higher scale.

Notes on germinating myxomycetous spores.—The paper upon the germination of spores of *Enteridium Rozeanum*, by E. J. Durand, in the March number of the GAZETTE, suggested to me that possibly my own experience was worthy of record.

In the early part of April, 1893, I brought in a specimen of *Reticularia umbrina* Fries. As soon as it was mature, five days later, spores were placed in ordinary drinking water, and in a few hours were found to have germinated. Further experiments showed that some spores germinated within from fifty-five to sixty minutes. Within ninety minutes one-tenth of the spores usually germinated, and few germinated later. The swarm cells remained active several days in the moist chamber. During the past year the spores of this and other specimens of Reticularia umbrina have been frequently germinated in my laboratory by different students, no difficulty ever having been experienced. By placing a quantity of the spores in some distilled water in a watch glass, millions of the swarm-cells will appear in an hour or two and form a conspicuous white layer, with the ruptured epispores and ungerminated spores as a substratum.

[3] Bonorden, Handbook.—Cornu, Reproduction des Ascomycetes, etc., Ann. d. Sci. Nat. Bot. VI. **3**: 53. *pl. 9. fig. 12.*

[4] This fungus appeared in the exhibit of the Agr. Dept. at the World's Fair, Chicago, 1893, among the diseases of cotton from Alabama, under the provisional name *Rhinotrichum macrosterigmatum* Atkinson, which name was never published.

In April of this year I collected a fresh specimen, and germinated spores from it side by side with spores from the specimens then a year old. I found that, as before, about one-tenth of the spores from the fresh specimen germinated, while one-third to one-half of the year-old spores germinated. The swarm-cells from the latter seemed to possess more vitality also, remaining alive in distilled water longer than the swarm-cells from the fresh spores. Very few of the latter were found active at the end of twenty-four hours. There was little difference in the time required for the germination of the two. The temperature was always that at which the air of the laboratory happened to be, no attempt ever having been made to keep the spores at any given temperature.

The diameter of the spores is about 8μ, of the amoeboid cells about 7μ, and of the swarm-cells about 6μ. Only uniciliate swarm-cells were observed.

I have also germinated year-old spores of *Diachaea leucopoda* Bull., *Hemiarcyria rubiformis* Pers., and *Fuligo septica* (Fries) Link., and spores of *Badhamia hyalina* Pers. two months old. Only a small percentage of any of these germinated, but the time required was less than three hours for any of them. Only amoeboid cells of Hemiarcyria rubiformis were observed. In all cases about one-half hour was consumed by the protoplasm in escaping from the epispore, and the time given above as the time required for germination is that between the moment they were placed in water and the moment the protoplasm assumed the swarm-cell form.

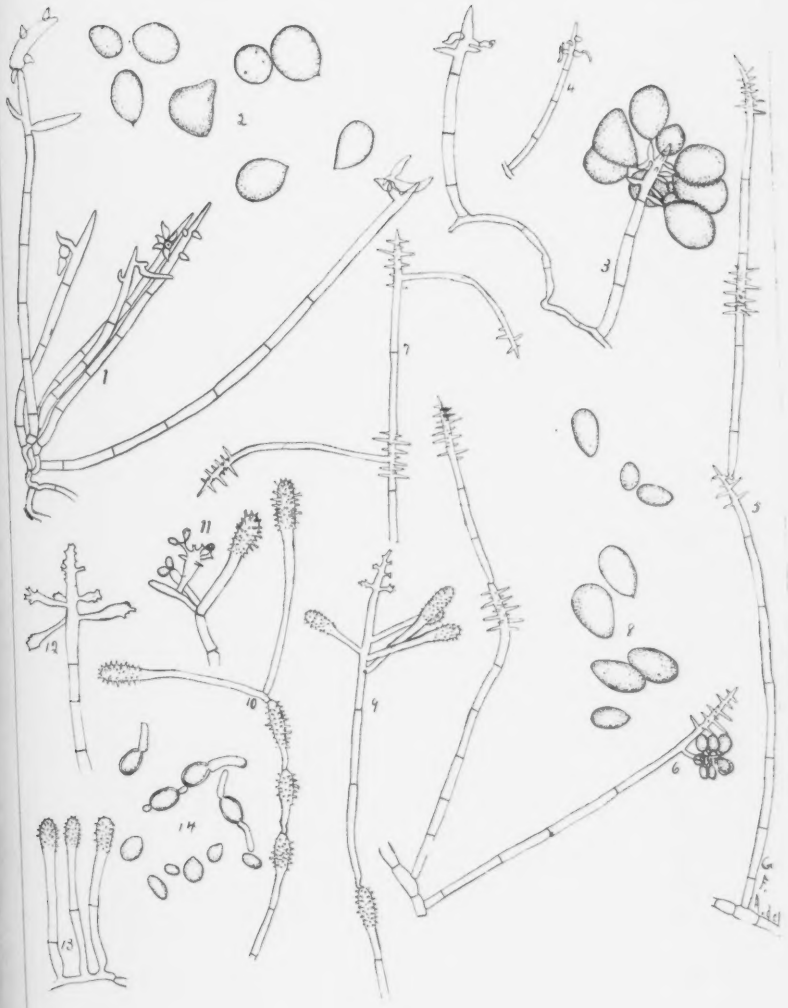
It will be seen that my experience agrees more closely with that of De Bary[1] than that of Durand. The time required for the germination of some of the spores is shorter, however, than that of which I find any record. I am indebted to A. P. Morgan for the determination of the specimens mentioned in this article.—Alfred James McClatchie, *Biological Department, Throop Polytechnic Institute, Pasadena, Calif.*

Sphaeroplea annulina (Roth.) Ag. **in Minnesota.**—This interesting alga has been previously reported from California by Dr. W. G. Farlow, upon the basis of collections by Mrs. Austin near San Bernardino [2] and so far as known to me this is the only authentic report of its occurrence in the United States. Wolle,[3] whether from a doubt concerning the identification or failure to note the definite terms of Dr. Farlow's announcement, states that "it is reported from Califor-

[1] De Bary, Comp. Morph. and Biol. of Fungi, etc. (Eng. trans.) 421 and 448. 1887.

[2] Farlow, W. G., Notes on fresh-water algæ. Bot. Gaz. **8**: 224. 1883.

[3] Wolle, freshwater algæ of the United States. 104. 1887.



ATKINSON on OLPITRICHUM, gen. nov.

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nia but without certain knowledge as to locality." This hesitant inclusion is apparently the basis of the doubtful attributing of Sphaeroplea to America by Wille [3] in his monograph upon the family, but the true state of the matter is shown clearly enough by Magnus [4] in a brief note upon the distribution of the plant, published in *La Notarisia*. There need be no further question, however, about the presence of this plant in the United States, since it was collected in quantity by Mr. D. T. MacDougal and myself, in inundated meadows near Bass lake, Hennepin county, Minn., April 23, 1894. The filaments were intermingled with those of Zygnema and Spirogyra and were found to include all stages of development. The formation of sperms, eggs and syngametes was noted and apparently at least two of the varieties recognized by De Toni [5] were present in the material studied. A further contribution may be looked for from the Minnesota laboratories upon this plant.—CONWAY MACMILLAN.

[3] Wille, N., Sphaeropleaceæ in Engler and Prantl. Nat. Pflanzenfam. Theil I. Abth. 2. June, 1890.

[4] Magnus, Paul, Nuova contribuzione alla conoscenza dell' area geografica della *Sphaeroplea annulina* Roth. La Notarisia **6**: 1215. 30 Ap 1891.

[5] De Toni, Sylloge Algarum. **1**: 95. 25 Jy 1889.

EDITORIAL.

A CORRESPONDENT takes the GAZETTE to task in this wise: "It appears to me that the GAZETTE contains too many articles that ought not to appear in print. . . . I would especially call attention to Mr. ——'s paper upon ——, and Mr. ——'s upon ——. These articles are too defective for the GAZETTE and do not add anything to our knowledge, but contain numerous poor statements of well-known facts."

We do not undertake to defend these papers, whose defects were fully recognized by the editors; or to set forth the reasons, to us sufficient, for accepting them for publication. We content ourselves with saying that we conceive it to be the duty of the GAZETTE to reflect as correctly as possible in papers published the state of investigation in the United States, and to urge (as we have repeatedly done and now do again) the necessity of increasing care in the preparation of papers offered for publication. It must be remembered that such criticisms as the above weigh chiefly against the authors. They do themselves discredit by the publication of any paper for which there has not been a careful consultation of all previous investigations along the same line, and at the same time tend to bring into disrepute, *prima facie*, all American investigators.

***

THE STATE OF THINGS described so forcibly in Professor Koehne's reply to criticisms upon the *Botanischer Jahresbericht* is highly discreditable to botanists. We are glad to have the facts brought to notice, however, for we hope that a knowledge of them will work the desired reformation. It is really marvelous that under such difficulties the *Jahresbericht* is published as promptly and is as complete as it is. We think the editor and his staff deserve the warmest thanks and highest commendation of the hundreds who have profited by their labors. We have been wont, heretofore, to excuse American botanists for carelessness in sending separates, but in the light of Professor Koehne's letter further failure will be inexcusable. Reader, if you write anything botanical for scientific journals, sit down quickly and enter Professor Koehne's address in your mailing list. We are glad to say that the BOTANICAL GAZETTE has long been one of the twenty journals which go regularly to the *Jahresbericht.*

CURRENT LITERATURE.

Minor Notices.

THE SECOND VOLUME[1] of biological lectures delivered at the marine biological laboratory of Woods Holl has recently appeared, the first volume having appeared in 1890. Ten lectures are included, all given by investigators upon subjects connected with their own work, and all presenting current problems. It would be impossible to review a work made up of so many important and independent parts, and where each part is the compact presentation of a large subject. It is sufficient to indicate such titles as are of botanical or general biological interest, and to state that this collection of lectures is one that every student of biology should read. The botanical and biological titles are: The mosaic theory of development, E. B. Wilson; The fertilization of the ovum, E. G. Conklin; On some facts and principles of physiological morphology, J. Loeb; Dynamics in evolution, J. A. Ryder; On the nature of cell organization, S. Watasé; The inadequacy of the cell-theory of development, C. O. Whitman; The influence of external conditions on plant life, W. P. Wilson; Irrito-contractility in plants, J. M. Macfarlane.

THE PROCEEDINGS of the Indiana Academy of Sciences for the year 1892 have been issued and recently distributed. They form a creditable volume of 169 pages and two plates. The botanical part embraces seventeen papers given by title only, and nine given in full or nearly so. The latter are: Grinnellia Americana, by M. A. BRANNON; Botanical field work in western Idaho, by D. T. MACDOUGAL; The application of mathematics in botany, by KATHERINE E. GOLDEN; Notes on certain plants of southwestern Indiana, by JOHN S. WRIGHT; Epidermis and spines of Cactaceæ, by E. B. ULINE; The genus Cactus, by E. M. FISHER; An auxanometer for the registration of the growth of stems in thickness (with plate), by KATHERINE E. GOLDEN; Notes on Pediastrum, by W. L. BRAY; and The Lilly herbarium and its work, by JOHN S. WRIGHT.

[1] Biological lectures delivered at the marine biological laboratory of Woods Holl, in the summer session of 1893. Large 8vo. pp. 242. Ginn & Co., Boston. 1894.

OPEN LETTERS.

A defense of the Botanischer Jahresbericht.

The criticisms uttered by Mr. J. Christian Bay in the December number of the BOTANICAL GAZETTE (18: 471–472. 1893) require an answer on the part of the editor of the *Botanischer Jahresbericht.* This answer must, above all, urge the incredible want of interest the greatest part of botanists take in the *Jahresbericht.* Indeed, the *Jahresbericht* mentions about 7,000 botanical writings every year, and what is the number of separates sent to the editor? 270–280 a year! The number of periodicals to be reviewed every year is certainly more than 1,000, and what is the number of periodicals the editor is presented with? About twenty! And Mr. Bay says: "A work of this kind ought not to rely *only upon donations!*" *Only!* It would be laughable were it not too painful. Mr. Bay will see from these data, that the editor, as well as his staff of collaborators, is relying a good deal upon "books and papers, which could be bought or otherwise promptly secured." The editor is not enabled to buy more than he does, for the botanical world neglects the *Jahresbericht* in still another manner: nobody buys it. There is a small number of public libraries, institutes and laboratories which acquire the *Jahresbericht* regularly, but private subscribers might be counted upon the fingers. Now, I ask Mr. Bay, whence should be secured the means for buying numerous periodicals not to be secured otherwise for the *Jahresbericht?* From the publishing bookseller? He is content with seeing his expenses barely reimbursed. From the editor? He lives with his family from his allowances as a teacher at a public school and does his work for the *Jahresbericht* for scientific, not for pecuniary interest, so that his work does not enable him to buy costly books and periodicals in a greater number. The same is to be said for the collaborators. They all stick to their work in the most disinterested manner, and sacrifice for the *Jahresbericht,* and consequently for botanical science, more time and labor than most botanists have any idea of. So I have to say to Mr. Bay: If botanists would buy the *Jahresbericht,* the editor might be enabled to secure more books or periodicals by buying, or by exchanging, though the *Jahresbericht* is much higher in price than most publications to be exchanged for it.

But, it must be added, periodicals are not what the *Jahresbericht* wants. It wants more separates. Many periodicals must be sent by the editor to half a dozen or to a dozen collaborators. So, a series of periodicals goes from Berlin to Luckenwalde; then, in due time, from Luckenwalde back to Berlin. After this, the editor has to prepare another set of books for Karlsruhe. Having got it back from Karlsruhe, he sends a third packet of new composition to Innsbruck, etc., etc. What enormous loss of time! It is impossible to allow the books to circulate among the collaborators, for the editor would need, in this case, to prescribe a peculiar course for every book, one book being destined for the collaborators A, B, C, D, E, the second for A, C, E, F, the third for B, D, F, G, etc., etc., and, moreover, the editor would lose all control. As to the collaborator reviewing periodicals in the libraries of his residence, he will spend a great deal of time in pay-

ing numerous visits (partly vain, partly successful) to the libraries. So his labor is immensely enlarged, the time he needs for finishing his report increases in a very troublesome manner. The *Jahresbericht* is published much later than the editor himself and the botanical world desire. This would all be changed if the botanists of all countries would think of sending their publications directly to the editor. These writings might then be distributed immediately among the collaborators, and these might work out the greatest part of their reports in their studies, with an invaluable gain of time, so that the *Jahresbericht* might be published more promptly. What a difference, for instance, for the bacteriological collaborator to have—as indeed he has —*one to three* separates every year from the authors themselves by the intervention of the editor, and to search for the rest of the bacteriological writings in several hundreds of periodicals,—or, as it ought to be, to have some hundreds of separates from the bacteriologists themselves! The *time* allowed every year for working off the extensive *Jahresbericht* is a factor Mr. Bay has entirely overlooked. The editor sets a greater value on the appearing of the *Jahresbericht* in due time than on its absolute completeness, and he is of opinion that a botanical author himself has a still greater interest in seeing his writings publicly known than his fellow botanists and the editor of the *Jahresbericht* have. Nevertheless, most botanists will do nothing at all for spreading abroad their articles, but depend entirely on the staff of the *Jahresbericht* or of other periodicals of similar character.—E. KŒHNE, *Friedenau bei Berlin, Kirchstr. 5.*

On compass plants and twisting of leaves.

If it be permitted, I would like to present a few remarks concerning the nature of the torsions in the leaves of the so-called compass plants. These torsions were described as twisting by Mr. Meehan (*supra*, pp. 158–159). The leaf-movements in the compass plants are, for good reasons, interpreted as heliotropical torsions. Now, Mr. Meehan states that these torsions result from "a somewhat prolonged effort of spiral growth."

Mr. Meehan has, evidently, confounded different movements. Having had some experience with compass plants, I shall be able, I think, to explain Mr. Meehan's results. The question is very simple, and belongs to the elements of vegetable physiology.

I. Compass plants. Experiments (the literature was given in my article on this subject in the Deutsche Botanische Monatsschrift 11: 1. 1893) have demonstrated that (1.) The vertical position of the leaves is assumed only when the plant is growing fully exposed to the sunlight. (2.) When the plant is growing in the shade, the leaves assume the fixed light-position. (3.) When the plants are so situated that they receive only the oblique rays of either the morning or the evening sun, the leaves place their superior surfaces at right angles to the incident rays. (4.) When the plants are under such circumstances that they receive the sun's rays only when the sun is high in the heavens, the leaves present their superior surfaces to the incident rays.

These results certainly indicate that the torsions are physiological. I think that Mr. Meehan's observations are very easily and simply explained from what we know of the relations of heliotropism to growth, which has been established mainly by De Vries, Müller-Thurgau, Ch.

Darwin and Wiesner (Die heliotr. Erschein. 1878–80), namely, that *heliotropic movements may become fixed by growth.*

That growth is rhythmic, and not continuous was known already to Ingenhouss and Th. de Saussure. We know that "growths that start together" are by *no* means likely to rest together, for although the question of individual differences has never been much studied, we are, in our studies, always troubled with individual variations.

The cause of the polarity is light; polarity may be changed, in *growing* leaves, into the fixed, normal light-position, when surroundings are changed; *grown* leaves will continually stay in the position of polarity. All that is needed to demonstrate this is a couple of drain pipes.

II. The twisting of leaf-blades was investigated by Wichura (Flora, —: 33. 1852.); since which time, these movements have not been much studied.

In monocotyledons, torsion of the leaves to the right takes place, when the scape is leaf-bearing, otherwise the leaves twist to the left. The list following shows some observations which I made in 1889.

Torsion to the right occurs in Allium (some); Bromus; Triticum; Secale; Hordeum. Torsion to the left occurs in Fritillaria; Allium (some); Festuca; Avena (upper leaves).

It has never been proved that growth is the primary cause of these movements, for an elimination of heliotropism by means of the clinostat has never been made. The twisting of leaves in Gramineæ is of much systematic value, and says ten times more than a thousand synonyms in a description.—J. CHRISTIAN BAY, *Des Moines, Iowa.*

"Minnesota Botanical Studies."

As editor of *Minnesota Botanical Studies* I regret that my selection of articles for its pages should, even in a single case, fail to meet with the approbation of Mr. F. V. Coville. My collaborateur is good enough not only to offer some useful statements of personal opinion, for which he has our thanks, upon certain debatable questions considered by Mr. E. P. Sheldon in a recent paper, but also to convey to me, through the GAZETTE, suggestions concerning what I may not without impropriety publish in the special journal entrusted to my care. Perhaps I may venture to note that *Minnesota Botanical Studies* does not hope to say the last word upon any of the matters touched upon in its columns. It is the opinion of the editor that even such preliminary contributions as he understands Mr. Coville to condemn are of value to him in the prosecution of the work he has in hand.

So far as *Minnesota Botanical Studies* is concerned, since it is supported by a Minnesota enactment, since it is a Minnesota work that it principally desires to do and since it is the wish of the editor that it be sent without price to whoever might be supposed to care for it, I hope no one will feel defrauded if some of its articles, from his broadly national point of view, seem too local and of too restricted interest for publication.

In the case in hand, while Mr. Coville's opinion of what the Minnesota survey should publish at a given moment and what it should retain in manuscript and how these manuscripts should be used, is of interest, I trust he will pardon me for suggesting that even the most unusual critical powers may be in danger of deterioration if dissipated over too wide a territory.—CONWAY MACMILLAN, *Minneapolis.*

NOTES AND NEWS.

IT IS ESTIMATED that forty per cent. of honey dew, as it occurs upon the leaves of trees, consists of the rare sugar, melezitose (Comp. rend. 117: 127).

ARTEMISIA STELLERIANA Bess. occurs at Little Compton, and Newport, R. I. In this connection an article in the March number of Journal of Botany should be read.—BAILEY.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will meet this year in Brooklyn, August 16th to 22d. Announcements may be obtained from the local secretary, Prof. Geo. W. Plympton.

DURING THE coming summer Professor John Macoun intends to collect in the prairie region of Canada. These constant explorations are bringing to the Government Herbarium a fine representation of our northern flora.

DR. G. A. WEISS, Professor in the University of Prag, and director of the School of Vegetable Physiology, died March 17, aged 57 years. Dr. Hans Molisch has been called to fill the position made vacant by the death of Dr. Weiss.

TEACHERS OF botany may be interested to know that *Negundo aceroides* shows a beautiful set of gradations through scales to true leaves. In the figure in Gray's Genera, vol. ii, their transition is only partially shown.—BAILEY.

MR. MERRITT FERNALD expects to publish shortly an appendix to his Name Catalogue, containing a record of work during the last two years. Nearly a hundred flowering plants have been added to the list, many of them of very great interest.

HEFT THREE of the *Berichte der deutschen bot. Gesellschaft* contains the following papers: R. Lauterborn, Concerning the locomotory movements of diatoms, with reference to O. Müller's papers on the same question (*Berichte*, 11: 571 and 7: 169); P. Taubert, On the occurrence of the genus *Physostigma* in Eastern Africa, and on some of its morphological peculiarities; P. Magnus, On some parasitic fungi of the Mediterranean territory.—BAY.

THE BOTANICAL DEPARTMENT at Brown University partakes of the general "boom" of the institution. Over 120 students have taken the course this year. The old laboratory, now too small for general classes, is newly fitted up for histological work. The larger classes have to hear lectures where they can. Much valuable apparatus has been added, and excellent work is being done. Mr. Osterhaut, besides being assistant here, acts in that capacity at Woods Holl, in summer, where he always sent a number of students.—BAILEY.

MR. S. E. CASSINO, the Boston publisher, having received requests from many persons to issue a directory of naturalists arranged by specialties or departments of study, and from others who desire a

geographical arrangement, has decided to publish such a directory of the United States and Canada, provided a sufficient number of subscriptions are received to warrant the undertaking. The names will occur in triplicate, alphabetically, geographically and by departments of study. If possible, the work will be issued in December of this year or early in January, 1895.

UNDER THE AUSPICES of the Belgian government, an international congress of scientists who are interested in the progress of applied chemistry will be held at Brussels from August 4th to 12th. There will be a section of agricultural chemistry which will consider nine important questions, some of which are most closely related to vegetable physiology. There will also be a section of biological chemistry which will have under consideration some questions concerning yeast. Professors H. van Laer and J. Vuylsteke are at the head of this section. Steps will be taken to publish a Review of biological chemistry in several languages. Papers may be read by the author or sent to the secretary, Prof. H. van Laer, 15 rue de Hollande, Brussels.—BAY.

THE MARINE BIOLOGICAL LABORATORY at Woods Holl, Mass., will be open for its seventh season from June 1 to August 30, 1894. The officers of instruction in Botany are W. A. Setchell, Instructor in Botany, Yale University, and W. J. V. Osterhout, Instructor in Botany, Brown University. The laboratory for teachers and students of Botany will be open from July 11th to August 18th. The laboratory work will be restricted to the study of the structure and development of types of the various orders of the cryptogamous plants, especial attention being given to the study of the various species of marine algæ, which occur so abundantly in the waters about Woods Holl. Applications should be addressed to William A. Setchell, 2 Hillhouse avenue, New Haven, Conn.

THE ANIMAL FOOD of Utricularia vulgaris has been carefully examined for plants growing in the Gullane ponds near Aberlady, Scotland, by Mr. Thomas Scott, of the Fishery Board for Scotland, assisted by his son (*Annals of Scottish Nat. Hist.*—: 105–112. 1894). No utricles were included less than one twelfth inch in greatest diameter. Of the first lot of 500 utricles taken from the plants at random eighty-one contained no organic matter, thirty-five contained organic matter too much decomposed to identify, and 384 contained recognizable organisms. The record is given in detail, but only the summary can be noted. In the 384 utricles were 1415 Cypris (mostly of two species), 535 Cyclops (nearly 90 per cent. being males), and seventy-one other minute animals, or an average of over five organisms to each utricle. After some weeks another lot of 300 utricles were examined with closely similar results. Five pieces of stem of Utricularia of an average length of six and one half inches were found to bear 1531 utricles, of which 1371 contained organic matter. According to the above average this would give over 7,000 organisms captured by these five short stems. A tow-net examination of the pond water showed no unusual abundance of minute animal life. Such plants must be powerful enemies to the active pond life. Several related questions are also considered by the authors, such as the reasons for a different proportion between the kinds of organisms inside and outside of the utricles.